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ABSTRACT

This paper describes Virginia Polytechnic and State University's efforts to effectively adopt emerging technologies on a general basis. The various systems that come into play in this context are discussed, including the macro-system (the university itself) and sub-systems (departments and programs). Introduction of a compensating sub-system, "Housecalls," is described. The "Housecalls" program was created in order to provide technical support for the college, provide a venue for training and supporting graduate students, and support faculty in their efforts to use their computers as educational tools. Research and theory in the area of diffusion and adoption of educational technology is summarized, including conditions that facilitate the implementation of educational technology. A theoretical model examining faculty needs when adopting emerging technologies in education is presented. General statistics about the "Housecalls" service, highlights from interviews with faculty, and observations from similar programs elsewhere are presented. It is concluded that educational institutions must support faculty on many fronts for successful adoption of emerging technologies. (MES)

A Systems Approach to Adopting New Technologies in Education

By:

Jared A. Danielson & John K. Burton

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Abstract

Many educational institutions face a variety of pressures to adopt emerging technologies in their every-day endeavors. If emerging technologies are adopted without adequately considering the systems in which they are to be used, the results can be less than desired. This paper describes one College's efforts to effectively adopt emerging technologies on a general basis. The various systems which come into play in this context are discussed, along with a theoretical model examining faculty needs when adopting emerging technologies in education. Educational institutions must support faculty on many fronts for successful adoption of emerging technologies.

Educational institutions face many difficulties in dealing with the adoption of new technologies in their educational endeavors. In an era in which political pressures include having the same proportion of computers on desktops in the U.S. as in Japan, or providing every school child with access to the internet, educators are constantly forced to adopt new technologies, if for no other reason than to "keep up." In the rush to adopt and change, it is easy to lose track of basic considerations, such as how the changes will affect learning, if at all, or how new technologies will be supported. This paper will examine the on-going efforts of one college to address the multi-faceted problems of adopting new technologies in an educational endeavor, and will do so in the context of general systems theory, theories of innovation, and our own hierarchy of faculty needs when adopting technology in education.

Defining Systems

Merriam-Webster (1998) defines "system" as "a regularly interacting or interdependent group of items forming a unified whole." Romiszowski (1981) points out that "a system exists because we have chosen to consider it as that." Using a bicycle as an example, he points out that a bicycle might be considered part of any number of systems (a transportation system, for example). A bicycle might also be considered a system itself, and might be said to contain sub-systems (such as the derailleur and associated shifting mechanisms).

Systems interact. In general, that which interacts with a system might be called an "input" and the result of the interaction (what any given system produces as the result of an input) is commonly called an "output." For a current example, a public school might be considered an educational "system"; having a new internet connection installed in every room might be considered an input to that system. Those who push for and pay for the new internet connections are probably hopeful that the resulting output will be higher grades, or higher mean scores on standardized tests, or "better educated" children. In the context of this paper, the university functions as the macro system, of which various micro systems, such as colleges and departments, are a part. The inputs and outputs we will examine have to do with the adoption and implementation of new technologies.

To approach a problem "systemically" entails more than simply acknowledging that the context for the problem in question can be considered a system which interacts with other systems. A systemic approach also entails examining a system's inputs and outputs and attempting to make changes that result in (hopefully) better, or more acceptable outcomes. If such an examination is done as the result of a problem, it frequently follows a pattern. Romiszowski (1981), provides a fairly representative pattern of a systemic problem-solving process: a) defining the problem, b) analyzing the problem, c) selecting and synthesizing an optimal solution, d) implementing the solution in a controlled setting, and e) evaluating and revising the solution. This pattern illustrates the basic structure for any number of systemic instructional design models frequently employed by professionals in our field (Gustafson & Powell, 1991).

Identifying the Systems in Question

A complete description of our instructional support context has been provided elsewhere (Danielson & Burton, 1999) to which the interested reader can refer if desired. The description here will be limited to providing that information necessary to understand the systems involved.

The Macro-System

The overall system to which we will refer is Virginia Polytechnic and State University (Virginia Tech), a large land grant university in south-west Virginia. The administration at Virginia Tech has long valued the importance of remaining abreast of emerging technologies. In keeping with these values, beginning in the early

nineteen nineties, the administration at Virginia Tech decided that it would be advantageous to provide faculty of the University with computers to aid in their instructional endeavors. This was realized through a program known as the Faculty Development Institute (FDI).

The goal of FDI was two-fold. First, FDI would place a computer on each faculty member's desk every 5 years. Second, FDI would provide faculty with the knowledge and skills necessary to use their computers for developing courseware. In exchange for receiving a new computer, each faculty member would be required to attend a series of 3-5 all-day workshops, aimed at teaching them how to use their new computers effectively. In a related effort, State Council of Higher Education in Virginia (SCHEV) monies were made available through the University to departments to spend on hard "technology" as they saw fit. In systems terms, the hope was that if hardware, software, and a training session went "in" (to the college/department systems) effective technology-assisted instruction would come "out."

The Sub-Systems

If the University is the macro system in the context of this paper, the sub-system of interest directly subordinate to it is the College of Human Resources and Education (CHRE) (once two colleges which were forcibly merged shortly after the advent of FDI). Faculty in the college returned from FDI with brand-new computers and a generally superficial knowledge of how to use presentation, e-mail, and web-browsing software. The technology was "in" the system and it was time to wait and see what came out.

Sub-systems (departments and programs) within the college played an important role. Some departments (including, generally, several from the education "side") used their SCHEV money to maintain and build on what was initiated with FDI. Computers were replaced when outdated, and efforts were made to keep software up to date. Other departments, on the other hand, tended to allocate their SCHEV moneys in other ways, leaving faculty and staff with old systems (both in terms of hardware and software) which became unreliable and difficult to maintain and support. Many faculty rarely or never used their computers for every-day tasks, much less to create and maintain courseware. Training that was not immediately useful was quickly forgotten. Even when the training might have been considered useful by some faculty, it was frequently not easily implemented. For example, the first several groups of faculty receiving FDI training learned how to do e-mail at a time when there were very few others to correspond with via e-mail.

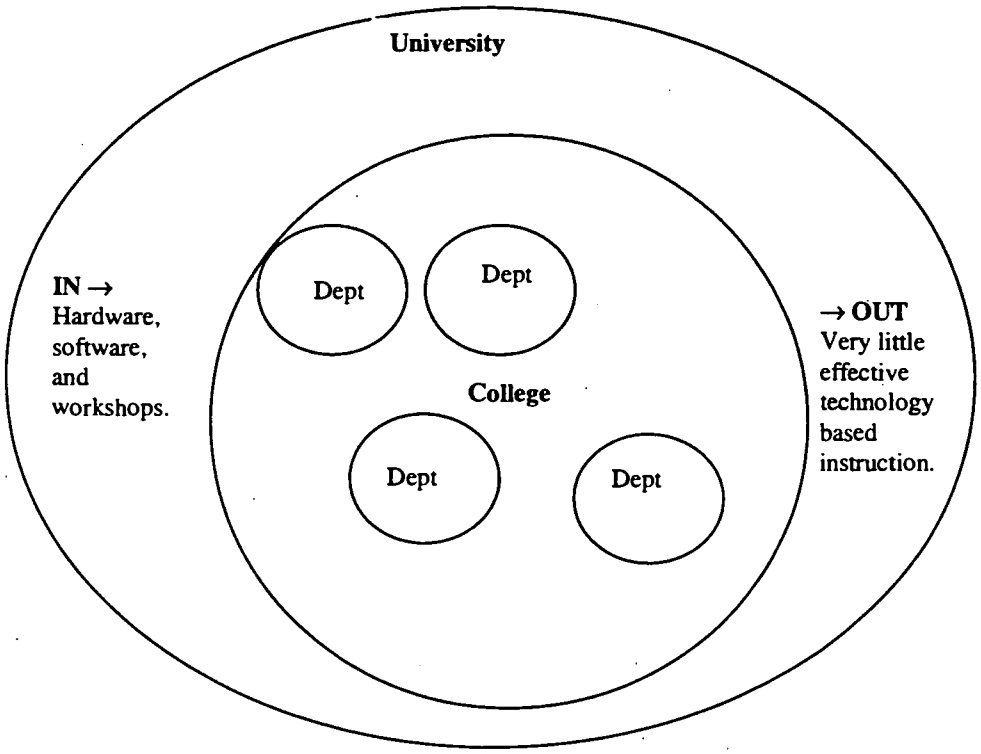
Those faculty who made an effort to use their new equipment and skills soon discovered other problems. While FDI had provided them with computers and training, it did not provide for follow up support to deal with the myriad of technical problems associated with computer use. Some professors, frustrated by incessant system crashes, inability to network correctly, inability to print reliably, etc., abandoned the thought of using their computers for course development. Some professors abandoned their computers altogether, and found vacancies for them on the floors of their offices.

Figure 1, below, illustrates what had occurred. The University "system" had introduced a new input into several sub-systems, with the hope that effective technology based instruction would emerge. As will probably surprise few experts in IT, however, the problem was not so simple, and the results did not meet hoped for expectations.

The fact that FDI alone did not result in faculty using emerging technologies effectively for teaching can probably be explained relatively easily. Scholars and practitioners in IT generally understand and accept that hard technology is not an educational panacea. Most IT experts could glance at figure 1 below and immediately suggest other "inputs" that, combined with hard technology and limited training would be more likely to result in effective technology-assisted training outcomes. Most would even suggest that, in the absence of an effective front-end analysis based on a well-defined "problem" any particular set of inputs amount to a "shot in the dark" at an unidentified target.

In this context, however, those working in the sub-systems of Virginia Tech were not generally given the option of determining the "inputs" (from the macro system) but were rather left to use, (or not use) what they got. Recognizing the difficulty faculty were facing in attempting to put FDI-gained knowledge and tools to work, administrators in the College of Human Resources and Education determined to address this multi-faceted problem

Figure 1. From the macro system into the sub-system



The most immediate problem facing the college appeared to be of a technical nature. Faculty were not using their newly acquired technology because they couldn't get it to work, or didn't know how to use it. Frequently, they turned to office staff for technical help, or to act as a buffer between themselves and their technology. (One faculty member, for example, would print electronic mail messages and ask a secretary to re-type them into a word document, because the faculty member was unfamiliar with the cut and paste function.) Meanwhile, office staff struggled with technical problems of their own. Frequently, they were unable to keep their own machines functioning properly, much less maintain machines for faculty members while still performing their regular work.

A Compensating Sub-System Introduced -- "Housecalls"

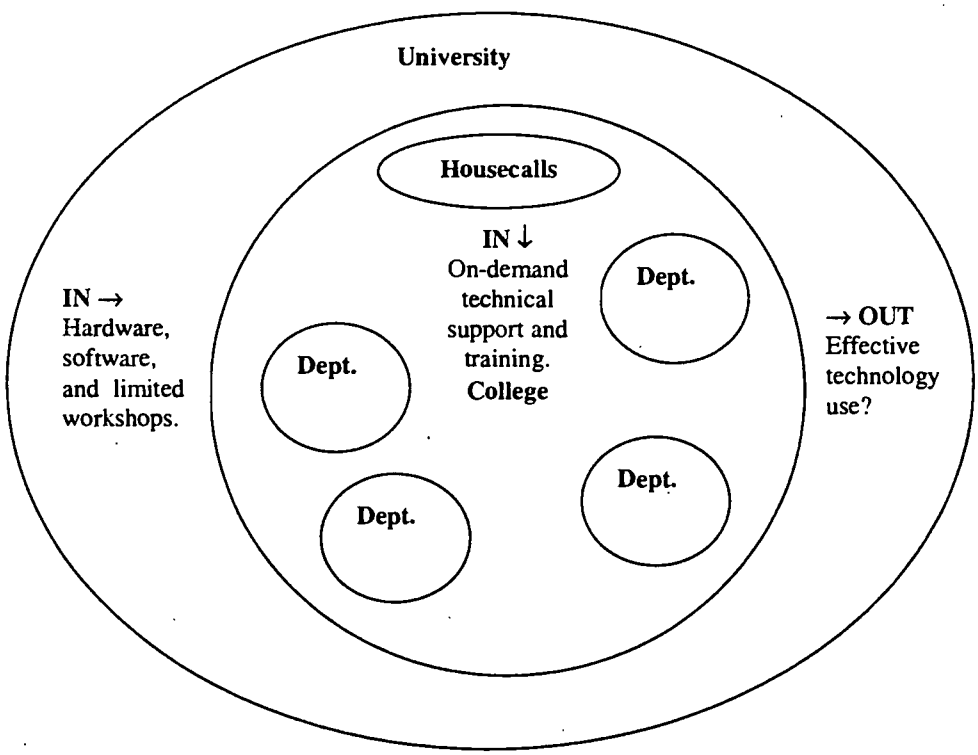
In an attempt to resolve the myriad of technical problems plaguing the college, administrators at the College level and within the department of Teaching and Learning determined to create a service which would, a) provide technical support for the college, b) provide a venue for training and supporting graduate students, and c) support faculty in their efforts to use their computers as educational tools. With this decision, the "housecalls" program was created.

The initial and primary focus of the housecalls program was to provide reliable, prompt (contact within the hour), and personal technical assistance to faculty within the college. Housecalls was not to be merely a technical service, however. It was to provide "human contact", (97% of housecalls calls are dealt with face to face), advice and on-the-spot training for technical and instructional questions, and in-service training for technical and instructional issues. The following points summarize the housecalls service as it exists in the CHRE (8/96 - 11/98).

1. Housecalls serves the College of Human Resources and Education including approximately 170 faculty and 65 staff using about 400 machines (Mac and IBM compatible).
2. Housecalls employs six GA's (at approximately $15,000.00/yr. = $90,000.00), one staff member (approximately $21,000.00/yr.), and other wage employees (approximately $10,000.00/yr.). Operating and inventory costs are approximately $15,000.00/yr. The total costs reach approximately 135,000.00/yr.
3. Housecalls handles on average 124 calls per month. Less than 3% are not handled in person, and less than 1% are referred to another level of maintenance. Time per call ranges from 2 minutes to 7+ hours. Technical difficulty of calls ranges from wiggling a wire to reformatting a hard drive and reinstalling all software. Level of difficulty of training-type calls ranges from teaching someone how to increase margins, to helping someone design an effective course web page or design an effective course strategy for asynchronous communication. Level of difficulty of calls increases as clients learn and become more sophisticated.

Returning then, to our systems analogy, figure 2 illustrates the role of housecalls -- introduced as a compensating system at the College level to provide additional inputs to those introduced through FDI. The administrators who introduced the housecalls program saw it as a tool to not only solve technical problems, but to also move the college in the direction of addressing the goal that led to FDI -- that of seeing faculty use emerging technologies effectively in their teaching. This strategy has been initially successful, as will be seen.

Figure 2. Introducing the Housecalls System to the University/College/Department System



Our Context and Theory of Diffusion and Adoption of Educational Technology

Before examining the specific results of the housecalls program, it seems appropriate to examine it from the perspective of research and theory in the area of diffusion and adoption of emerging technologies in education. In his summary of such research, Holloway (1996) concludes that three factors: training, resources, and involvement, are consistently shown to be instrumental in the adoption of emerging technologies by educators. The housecalls program's focus is primarily on providing the former two (in the form of technical support), and not on the third (encouraging faculty involvement in adopting emerging technologies). Such an emphasis seems appropriate in our context for two reasons. First, it hardly seems appropriate for educational technologists to "push" hard technology use for its own sake in any situation. Second, research seems to indicate that teachers and faculty are most moved to adopt emerging technologies in their educational endeavors when they see peers doing so (as opposed to being "pushed" to do so from the outside) (Holloway, 1996).

Rogers, (1971) one of the pioneers in the field of diffusion research, introduced five attributes of innovations: relative advantage, compatibility, complexity, trialability, and observability. Ely, (1990) building on the work of Rogers and others, identified eight conditions that facilitate the implementation of Educational Technology. His work is still consistent with more recent findings, and his eight conditions provide a convenient framework for analyzing our context. We will briefly examine each of Ely's conditions, providing examples from our context which demonstrate the presence of these conditions. Those conditions are: a) dissatisfaction with the status quo, b) knowledge and skill exist, c) resources are available, d) time is available, e) rewards or incentives exist for participation, f) participation is expected and encouraged, g) commitment by those who are involved, h) leadership is evident.

Housecalls and Ely's Eight Conditions

1. **Dissatisfaction with the Status Quo:** Clearly, most faculty and staff in the CHRE were dissatisfied with a situation in which they were expected to use computers without technical support. (It is unclear

the extent to which initial dissatisfaction led faculty members to take FDI machines in the first place). The housecalls service does address faculty dissatisfaction with technical problems. Increasingly, dissatisfaction in other areas is leading to other kinds of implementation as well. For example, at Virginia Tech more and more students are demanding the luxury of having notes and outlines, etc. on-line. This is causing some faculty to change in ways that they probably would not have otherwise.

2. **Knowledge and Skill Exist:** The housecalls program is staffed by graduate students in the Instructional Technology program in the Department of Teaching and Learning. The collective knowledge and skills of this group makes providing technical assistance possible.
3. **Resources are Available:** Without the availability of money from the State Council of Higher Education in Virginia (SCHEV) equipment trust fund, and original FDI-provided computers, most faculty and staff would not be able to support original purchase of or continued upgrading of equipment and software. In the department of Teaching and Learning, all faculty and staff are provided with a computer to take home and work/play on. The department also provides a modem and pays the monthly internet access fee for faculty and staff.
4. **Time is Available:** It is not clear that faculty at Virginia Tech have any more time to spend adopting new technologies than faculty anywhere else. Indirectly, however, the housecalls program does "give" faculty time, because those who use hard technology can spend less time fighting trivial technical problems.
5. **Rewards or Incentives Exist for Participation:** Faculty members receive new computers for participating in FDI. Increasingly, there is anecdotal evidence to suggest that faculty are rewarded for adopting emerging technologies and effective instructional design strategies in the form of higher approval from students. There are formal incentive structures which encourage adopting emerging technologies in instruction as well. The university supports a grant program which awards monies for an "innovations in learning with technology" program. Similarly, the College of Human Resources and Education has an Associate Dean of Innovations, who allocates monies for the implementation of instructional technology. It is not clear, however, whether or not faculty efforts in this area will be rewarded in the area of promotion and tenure.
6. **Participation is Expected and Encouraged:** Faculty members are required to participate in FDI. Various innovations (such as the use of e-mail) are also required on a department by department basis.
7. **Commitment by those who are involved:** Because the housecalls program was started at the College level, and because FDI was started at the University level, there is commitment to the success of each from administrators. Similarly, in the case of the housecalls program, because the services provided are so universally required, there is general commitment to its continued success. The fact that the housecalls program continues to be funded, in spite of the non-trivial costs involved, is perhaps the surest indication of commitment on the part of decision makers.
8. **Leadership is Evident:** Various leaders have proven instrumental in the support of the housecalls program, and in the adoption of emerging technologies in the College of Human Resources and Education. At the University level, the provost has stressed the importance of utilizing new technologies as much as possible. At the College level, the Dean of Innovations has consistently supported and funded initiatives to integrate technology in teaching and learning endeavors. The department chair of the department of Teaching and Learning has also been instrumental. He introduced and championed the housecalls program, and has consistently supported the department of teaching and learning in adopting new technologies. He has also stressed the importance of thoughtful application of technology, acknowledging the weaknesses of using technology for technology's sake, and stressing the importance of supporting faculty regardless of their support needs.

Hierarchy of Faculty Needs when Adopting Technology in Education

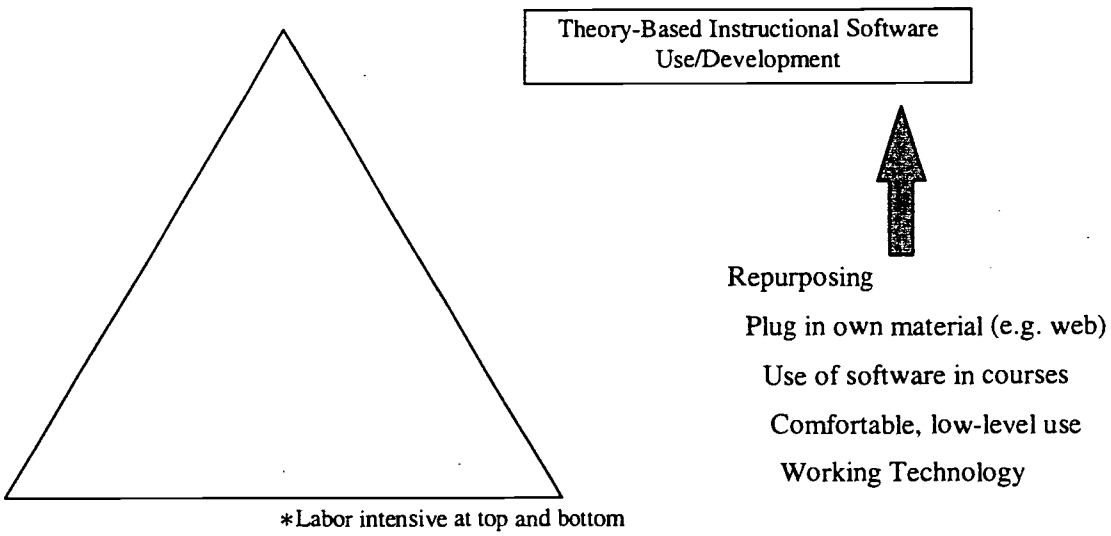
Our experience with the housecalls program and the intriguing set of circumstances leading to its creation have led us to conceptualize a model for conveying faculty needs in adopting technology in higher education. If research suggests that training, resources, and involvement are required for the adoption of emerging technologies in education, then our model assumes involvement (i.e., faculty are seeking to use emerging technologies already, -- we are not pushing it) and suggests an order in which training and resources might most effectively be provided.

In early 1999 we introduced a "hierarchy of instructional technology needs" (Danielson & Burton, 1999) reminiscent of Maslow's (1970) hierarchy of needs. Maslow's hierarchy illustrates the theory that meeting certain fundamental human needs is prerequisite to meeting others. In his hierarchy, the need for food and shelter is fundamental, and is prerequisite to meeting higher needs such as the need for human affection.

In our analogy to the implementation of educational technology, certain basic technological needs precede and are prerequisite to others. Our original version of the hierarchy of faculty needs when adopting technology in education appears in figure 3 below. As can be seen, we proposed that the most basic of all requirements (if faculty

are to use these tools effectively) is that of having equipment functioning properly. The highest level requirement is that of creating good, theory-based instructional products. Clearly, while the latter is the ultimate, and certainly more glamorous goal, we argue that it will not happen until the requirements below it have been met. It has also been our experience that the needs which require the most time to address are those found at the top and the bottom of the pyramid. Therefore, any endeavor which strives to meet these requirements must have the ability to spend a great deal of time and resources "at the bottom" before moving its way up. Furthermore, we argued that it is futile to "sit at the top" of the pyramid, so to speak, and wait for faculty to come ask for assistance with weighty and important matters of theory and development. This is the case because, a) most faculty, without support at the bottom, will never arrive at the top, and b) those faculty who have had the drive to arrive to the top unaided are unlikely to solicit help once there.

Figure 3. Hierarchy of Faculty Needs when Adopting Technology in Education

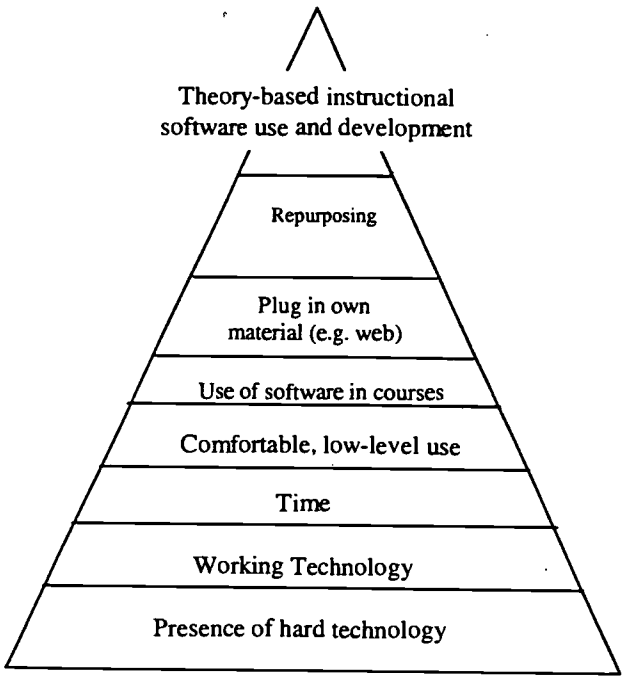


Supporting and Enhancing the Hierarchy

Since conceiving of the hierarchy presented above, we have had an additional year to examine our assumptions, collect additional relevant data, watch the housecalls program at work, and talk with faculty. We have observed a fair amount of anecdotal evidence supporting the underlying assumptions of the hierarchy. Our experience with the housecalls program, as well as our conversations with faculty members have also led us to make several adjustments to the bottom of the hierarchy. First, because there is clearly an important distinction between the presence of hard technology (e.g. hardware and software), and "working technology" (which implies that the technology gets fixed when it breaks), we have chosen to divide the "working technology" section into two sections: a) presence of hard technology, and b) working technology. Second, because the necessity of time is such a prevalent part of relevant literature, and because we've found it mentioned so frequently by faculty as an essential factor, we have also chosen to include it as a "need" on the hierarchy. The adjusted hierarchy appears in figure 4, below.

Data supporting our assumptions can best be summarized through general statistics about the housecalls service, highlights from several in-depth interviews with faculty from the CHRE, and finally, several general reports of how similar programs are being implemented elsewhere.

Figure 4. New Hierarchy of Faculty Needs When Adopting Technology in Education



General Statistics on the Housecalls Service

Observing the trend of housecall use since its introduction in August of 1996 reveals the following:

1. Since its introduction in 1996, the requirement for housecalls services has remained stable. Housecalls handles, on the average, 124 housecalls per month. However, housecalls staff indicate that the nature of the calls is becoming more complex. This could indicate that, while faculty and staff are becoming more sophisticated and calling on housecalls less for trivial service, they are also managing to "get into more trouble" (i.e., their use is more sophisticated, and, therefore, their problems have become more sophisticated as well).
2. While the need for basic technical support has remained solid, there has been a gradual increase in requests for services "higher up the hierarchy." Lately, this has come mostly in the form of faculty requests for help designing and "putting up" web pages. We believe that this indicates a couple of things: a), faculty and staff are learning how to solve some of their simpler low-tech problems, making them more willing to take on "higher-tech" ones. b) Faculty and staff have developed a trust for housecalls and are willing to call on them for one-to-one training. c) Faculty and staff are actually doing more sophisticated instruction with their technology (i.e., they're higher up the pyramid) than they used to be. This is due, in part at least, to the fact that they aren't being held back by lower-level problems. Interviews with faculty indicate that web page development is also partly due to pressure felt from students who are demanding more availability of services on-line.

Interviews with Faculty

Four faculty members who have called upon housecalls for help with higher-level tasks were interviewed at length regarding their technology use in their teaching endeavors. These faculty come from a variety of backgrounds. Two have taught several televised courses. Another has taught a course that was conducted strictly on-line. The other is the editor and manager of an on-line journal. All also use (to varying degrees) electronic presentation software and web pages in their instruction.

Several basic trends could be found throughout all the comments of the faculty members. First, all agreed that basic support in the form of university-supplied computers and technical assistance is very important, (and in three of the four cases) essential, to their adoption of emerging technologies in education. None of the faculty members expressed willingness, with their own money, to provide themselves (at work) with a computer equivalent to the one that had been supplied by the university.

Second, all faculty members (consistent with Ely and others) indicated that the availability of paid time to develop technology-assisted courses is a great help in doing so, and that the lack of time is a major deterrent. One professor commented that he was able to build an on-line course because the University bought out his classes for a

semester so that he could have time to dedicate to the course he was building. Two mentioned that they have not been able to make desired technological enhancements to courses they teach for lack of time to do so.

Similarly, all faculty stressed the importance of the housecalls program. All four mentioned both housecalls' training and technical support functions. All mentioned the convenience of having a housecalls representative available the same day (and frequently the same hour) as their request for assistance to deal with problems. Issues that they felt they would have spent hours resolving on their own, they were able to refer to housecalls, and spend their time on other endeavors. Three faculty members went so far as to say that they would not have been able to use the technology they are using without the support of housecalls (or a similar service), and the other acknowledged that attempting to do what they had done without housecalls would have been very difficult.

The faculty members interviewed also reported relying heavily on housecalls for learning how to use their teaching tools. For example, one learned how to design, build and "put-up" a homepage through several hour-long sessions with a housecalls staff member. Another spent similar long hours getting questions answered relating to how to use the Mac operating system to transfer files, and then, after switching to a PC platform, how to use the PC for file transfer -- all within the context of building a web page for a class.

Finally, housecalls was considered important for its continuity. After a call has been completed, a housecalls staff member calls the faculty or staff member who was served to verify that the problem was solved and check for subsequent problems. Records are kept on all calls made, so specific recurring problems can be dealt with in a systematic way. Faculty consider this kind of continuity valuable.

Generalizability of Housecalls and the Hierarchy

Obviously, our observations lack statistical generalizability. However, there is some evidence that the principles discovered here are applicable elsewhere. Several colleges in the Appalachian College Association have built support structures for their colleges patterned after the housecalls service. The following observations come from administrators at two of those colleges, who have been involved in such programs.

1. The two programs investigated are quite similar to each other. Both employ 10 staff members, and serve about 200 hundred faculty and staff and 1000-1500 students. Both provide software and hardware support.
2. Both programs report that technology use by those supported (ranging from e-mail correspondence to having and maintaining web pages) has increased dramatically since the services began.
3. Both programs report requests from faculty and staff for services beyond the services provided. In one case, faculty are requesting support for web page development (which is not provided). In the other, users want more computers available for checkout, and service of personally-owned computers (which is not provided).
4. Both programs report that faculty are using the new support services to employ emerging technologies in their instructional efforts. This use ranges from setting up web-sites for students to access, to using presentation software for teaching classes.

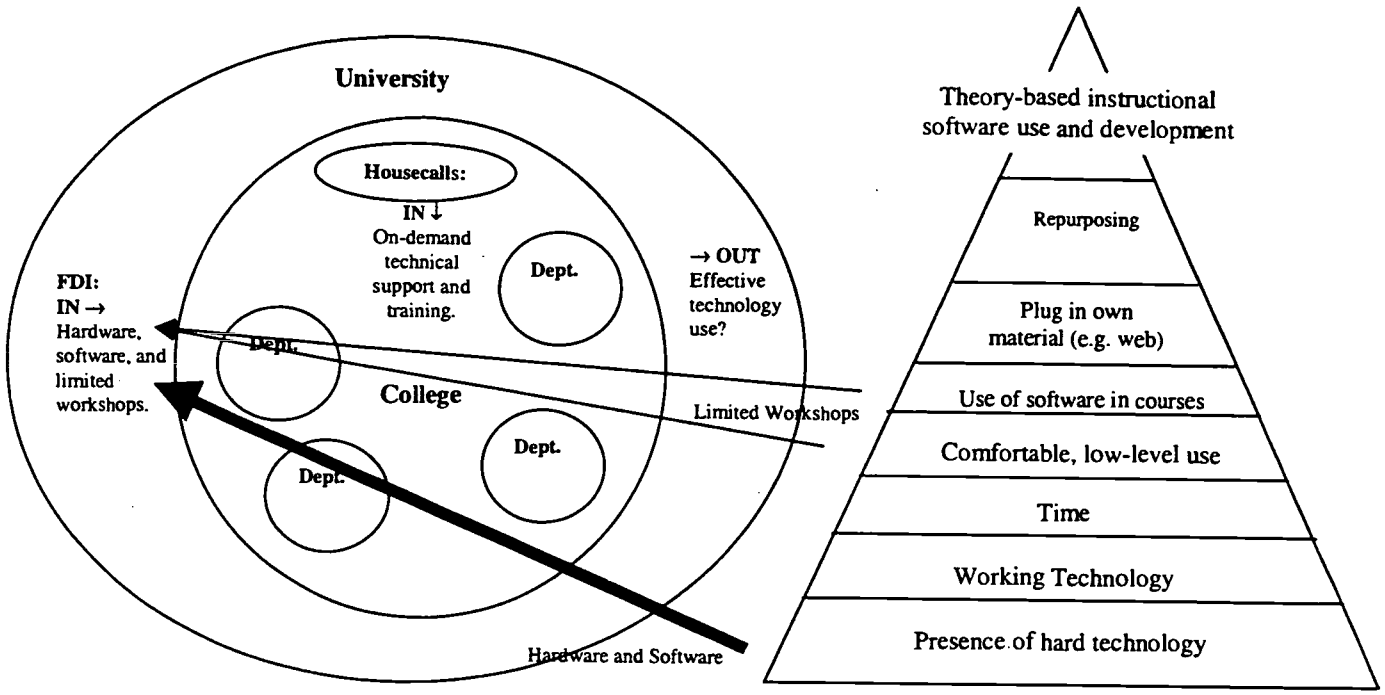
In general, what administrators at these colleges have found seems consistent with the idea that educators will not and cannot use emerging technologies effectively without support, and that, given support, they will be more likely to use emerging technologies in their teaching.

Systems and the Hierarchy of Faculty Needs when Adopting Technology in Education

FDI (The Macro-System's Contribution)

We will return now to our context at Virginia Tech, and the systems that we initially examined. We suggested that the university might be considered a macro-system of which Colleges (in our case the CHRE), departments, and programs play a role as sub-systems. In summarizing the University's initiative to encourage faculty use of technology in teaching, the university made available money for computer equipment, and a training program in the form of 3-day to one-week seminars (FDI). Comparing this to our hierarchy (see figure 5 below) this seems an appropriate first step in promoting the use of emerging technologies in education. This is the case because the most basic element of working technology (looking at the bottom of the pyramid) is hardware and software. The two upper arrows in figure 5 illustrate FDI's initial training efforts, and the bottom arrow demonstrates the initial hardware and software in. The fact that the FDI program was inadequate for achieving the desired outcome (theory based instructional software use and development), does not negate the value of either of these initial inputs. They simply were not enough.

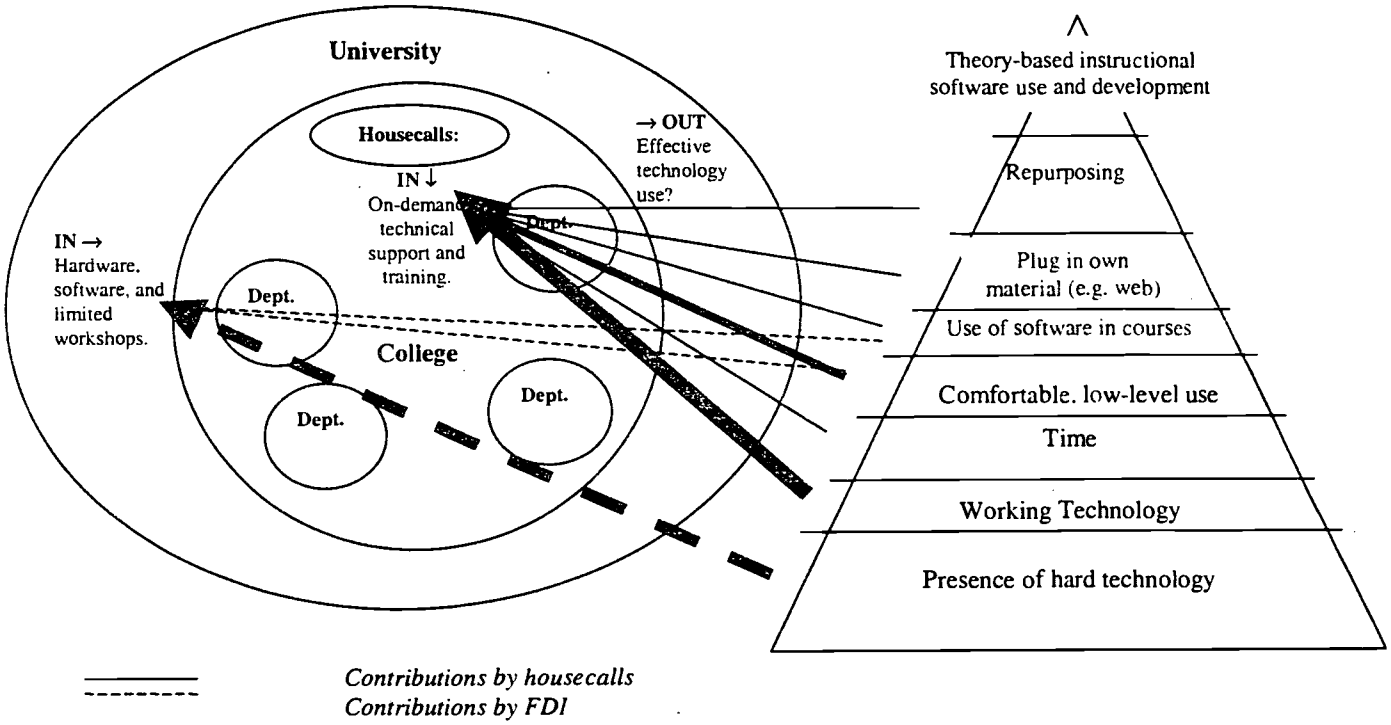
Figure 5: FDI's contribution to the University's End Goal



Housecalls (One Sub-system's Contribution)

The fact that the original FDI efforts were not producing the desired outcomes led administrators in the CHRE to introduce new system "inputs." The input in this case was a new system, "housecalls." Figure 6, below, illustrates how the housecalls system specifically contributed to meeting specific faculty needs. As the arrows reflect, the housecalls program has provided some service for faculty, at nearly every level of the hierarchy, though, as the thickness of the arrows is designed to indicate, the bulk of that support continues to focus on maintaining working technology. It seems clear, nonetheless, that the housecalls service has helped compensate for some of the deficits left by the FDI program in moving towards the ultimate goal of theory-based instructional software use and development. It also seems clear that if university and college administrators are serious about wide-spread theory-based instructional software use and development, there are still some pieces of the puzzle missing. The most notable of these pieces is time. While the housecalls service continues to "free-up" faculty time somewhat, it still seems clear that for most faculty to consistently use new technologies effectively, they must be given time to do so. We also anticipate that as more faculty attempt to integrate emerging technologies in their courses, the housecalls service will receive an increasing number of requests for service higher up the hierarchy. As the need for technical support will likely remain strong, housecalls will likely need to expand somewhat to meet the increased need, or another system will have to be introduced to provide more specialized service.

Figure 6: Housecalls and FDI Contribution to the University's End Goal



Conclusion

Given current political and educational climates, there may be any number of reasons why educators might be expected to adopt emerging technologies in their educational endeavors. Our hope is that regardless of the context, the hierarchy we have provided might prove useful to practitioners who have "pieces" of a technology solution, or who are trying to put one together. We contend that anyone seeking to adapt emerging technologies in an educational endeavor must take into consideration all the "technology" needs faculty will face, and the order in which those needs are addressed.

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